

LIFE HISTORY PARAMETERS OF THE CRAYFISH *ORCONECTES LIMOSUS* (RAF.) IN SOUTHERN NEW ENGLAND¹

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Abstract. *Orconectes limosus* is a primitive species of the genus *Orconectes* separated geographically from related species occurring in the Mississippi and Cumberland River systems of North America. Investigation of the life history of *O. limosus* was undertaken near the northern limit of its distribution along the Atlantic coast. In southern New England, the species copulates any time of the year when active first form males confront females. Egg laying commences in April and lasts to early June, and hatched young appear in June and July. Abdominal egg counts are linearly and positively associated with carapace length. A trend exists where older females commence ovipositing earlier in the season than smaller adult females. Individuals can live up to 3 years but not usually beyond 2 years. *Orconectes limosus* shows no extraordinary life history when compared with other species of the genus.

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The spiny river crayfish, *Orconectes limosus*, is unique among the so called limosus section (Ortmann 1905) crayfishes in that it is confined to the northern Atlantic Coastal Plain and Piedmont from the James River in Virginia north to south flowing river systems in New England.

The life history of this species has been speculated and noted upon by several workers who have engaged in faunistic crayfish studies that included *O. limosus*. Citations of dates of collection of one or a few females with eggs or young have been documented along with observations on dates of copulation (Ortmann 1906, Crocker 1957, 1979, Francois 1959, Aiken 1965). Summaries of the annual cycle of *O. limosus* (Crocker 1957, Meredith and Schwartz 1960) state that copulation generally occurs in the fall while egg laying takes place in the spring. Crocker (1957, 1979) has provided adequate data on chronological molting patterns and identified the periods when potentially reproductive first form males are most abundant. The extensive *in vitro* studies by Andrews (several papers summarized somewhat in 1907) have detailed social, behavioral and embryological features of the reproductive biology of *O. limosus*.

The present study is an attempt to elaborate on previous accounts. Expanded quantitative and qualitative data, afforded by a large collection of *O. limosus* from southern New England, is presented in order to describe some life history characteristics of *O. limosus* in the northern part of its range and to compare them with observed life history patterns in other northern members of the genus.

METHODS AND MATERIALS

Data gathered in this study was drawn from 406 specimens collected from east to west in the Pawcatuck (3 lots), Thames (9 lots), Connecticut (66 lots), and Housatonic (3 lots) River systems. Five collections were made in minor coastal streams in Connecticut. All specimens are currently maintained in the Invertebrate Division of the Museum of Zoology, University of Massachusetts at Amherst and specific museum numbers and localities can be furnished upon request. Specimens collected from ponds or localities that I interpret to be out of the natural range of *O. limosus* (northern New England) were excluded. Additionally, I consulted collections of *O. limosus* from southern New England at the Yale Peabody Museum, New Haven (YPM) and the Museum of Comparative Zoology, Cambridge (MCZ) for the presence of females with attached eggs or young.

Carapace length measurements were made with the use of a Helios @ dial caliper. Juveniles under 15 mm carapace length were measured with a calibrated ocular micrometer in a binocular dissecting microscope and I counted only attached eggs or young. Ovarian egg counts were not made since realized reproductive potential is reflected only in those eggs which are fertilized and attached to abdominal pleopodia.

RESULTS AND DISCUSSION

As reported in the literature, copulation in *O. limosus* has been most often observed in the wild in late summer, fall and early

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winter (Ortmann 1906, Crocker 1957, Francois 1959) and occasionally in late winter (Francois 1959). I observed copulation in later summer (August) and in late winter (March) and late spring (May) in southern New England. Based on my findings and earlier reports, it is suggested that no strict fall mating season exists and copulation can occur any time an active first form male confronts a female.

Egg Laying and Fecundity. Specimens of *O. limosus* have been reported with attached eggs in May and June (Ortmann 1906, Francois 1959, Aiken 1965, Crocker 1979). Females with attached young have been found in May and June as well (Ortmann 1906, Francois 1959), and the earliest date in my observations is 28 April. A single female with eggs listed as only "Connecticut" in the YPM was collected on 17 April 1941. Egg laying continues through to early June. Attached hatchlings (first through third instars) have been observed in late June and early July (three specimens). A female in the MCZ with attached young was collected on 14 June 1912, in Great Barrington, Berkshire County, Massachusetts.

A linear relationship exists between the number of attached eggs or young and parental carapace lengths as indicated by strong correlation of values ($r=.904$), which is significant ($z=5.19$, $P<0.5$). The positive association of increasing carapace length and corresponding increases in fecundity also is shown by regression analysis (figure 1). A single large 3 year old female bearing few eggs was omitted from correlation analysis as it was believed that extreme age of this crayfish resulted in reduced fitness and poor egg production. It has been shown elsewhere (Momot 1967) that very old females sometimes become reproductively senile and are unable to attach extruded eggs or to remain very active during egg laying periods, possibly due to a hormonal deficiency, causing eggs to dislodge. The number of eggs attached to abdominal pleopodia ranged from 57 to 396 with a mean of 163 ($n=35$). The average size of an egg laying female was 29.8 mm

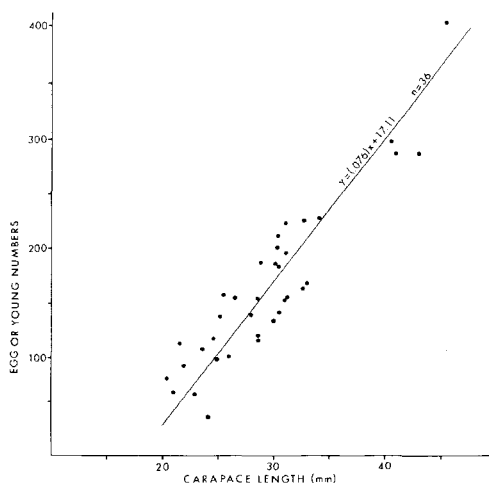


FIGURE 1. Linear regression of attached eggs or young versus carapace length in *O. limosus*. Open circle represents ovigerous female not included in analysis (see text).

carapace length with a range of 20.4 to 45.5 mm.

An apparent age succession occurs among reproducing females such that larger and presumably older females commence egg laying early in the season subsequently followed later on by smaller, younger females. This succession may be the result of differential temperature effects on egg laying activity in different sized crayfish such that oviposition in smaller females may be cued by comparatively higher ambient temperatures than in larger females.

Age Structure. Attempts to identify age structure in crayfish species have been complicated by differential growth rates causing overlap among various age groups, particularly middle age groups (Momot 1967, St. John 1976). Zero year *O. limosus* were easily detected during June and July when free living post-instars started to appear in collections. One and 2 year old specimens were separated with more difficulty. The method of identifying cohorts used by Momot (1967) was employed in this study for individuals over one year old.

The cohort structure (figure 2) suggests that *O. limosus* can live up to 3 years in southern New England but normally lives

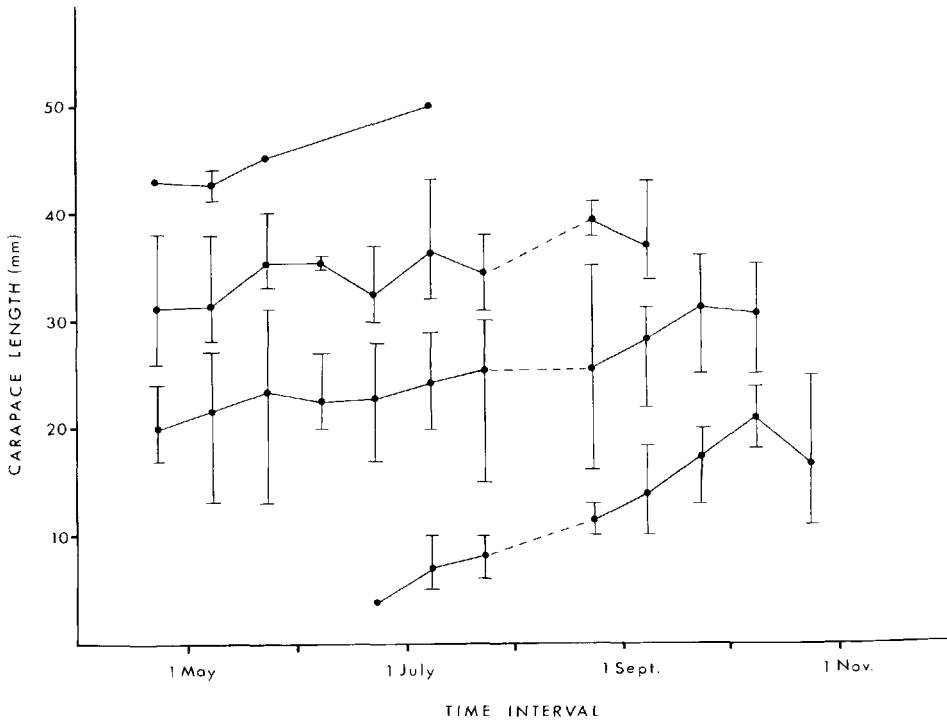


FIGURE 2. Cohort structure of *O. limosus*. Dots indicate sample mean carapace length while bars show total range of lengths. Data sets were determined by combining biweekly samples. Dashed lines represent period for which data was inadequate.

to only 2 years. Marked growth increments in May and June and September compliment Crocker's (1957, 1979) observed molt cycles. Possibly males mature by the end of their zero year, using Crocker's (1957) minimum carapace length of data for adjacent New York animals, but probably do not normally mature until the beginning of their first year. The smallest ovigerous female I observed (24.4 mm carapace length) suggested that females mature at the end of their zero year or during their first year. Crayfish continue to remain abundant throughout their first year but during the latter part of their second year begin to disappear. Their decrease is evidenced by a reduction in mean carapace length in 2 year olds during later summer; however, a few second year animals manage to survive to their third year.

It is of interest to attempt to find unique features in *O. limosus* reproductive biology

that might reflect some ancestral or primitive reproductive strategy among species of the genus occurring in northern latitudes. The species shows many ecological tendencies that have been characterized as generalistic in crayfish and indicative of a primitive evolutionary standing (Hobbs 1969, Hobbs and Barr 1972).

A synthesis of several studies (Momot *et al* 1978) shows spring breeding and early late summer growth as being characteristic of species of *Orconectes* in seasonal cool to cold temperature environments. Longevities never exceed 3 years except for *O. limosus* introduced into Poland (Kosakowski 1971 in Momot *et al* 1978), which allegedly lives up to 4 years.

Orconectes limosus in southern New England achieve the same or slightly larger average size than latitudinally equivalent species of *Orconectes*. Females reach maturity at lengths similar to that of other orconec-

tine forms. On the average, *O. limosus* produces more abdominal eggs than smaller propinquoid orconectines and about the same number as similar sized forms (*O. virilis*, *O. rusticus*) indicating no unique patterns of reproductive biology among studied species of the genus *Orconectes*.

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